Advanced Mirror Technology Development

Revolutionary concepts for rapid, cost-effective large aperture mirror technology

Christopher H. M. Jenkins

Compliant Structures Laboratory

www.compliantlab.sdsmt.edu

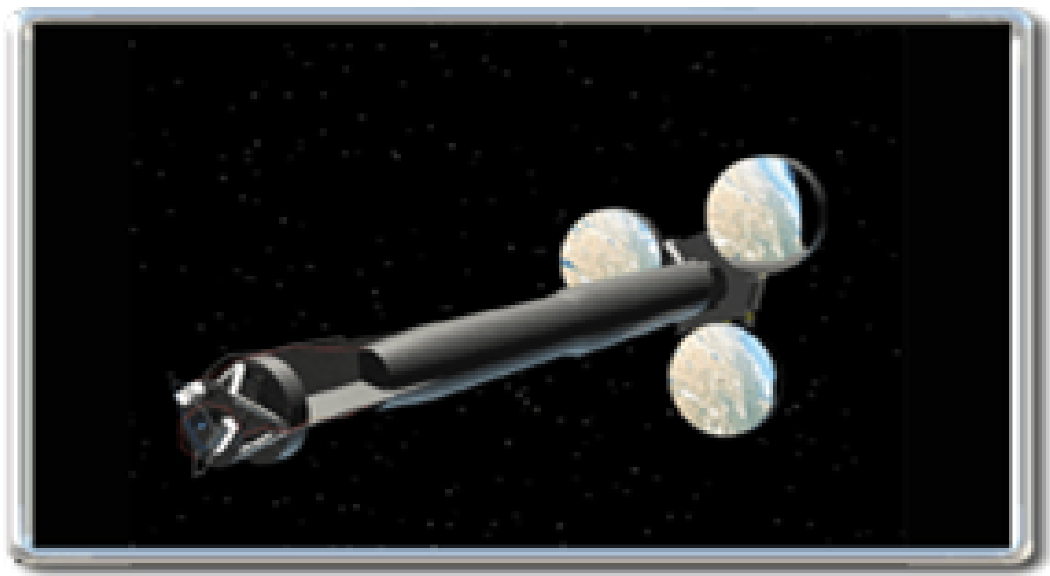
Mechanical Engineering Department

S. D. School of Mines and Technology,Rapid City, SD 57702

christopher.jenkins@.sdsmt.edu

Introduction

The mission of the AFRL/VS Advanced Mirror Systems program is the development and demonstration of mirror technologies critical to the cost-effective development of large aperture space-based optical systems during the next 10-20 years.

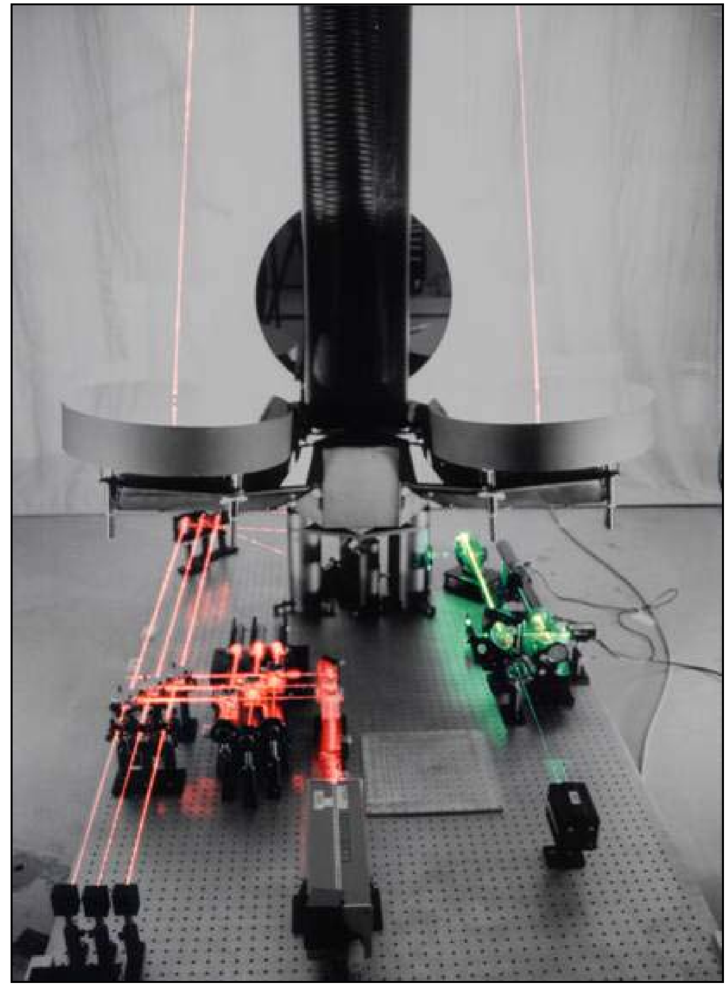


Introduction

- The Compliant Structures Lab at SDSM&T has worked for several years with AFRL/DE and VS on membrane mirror technologies.
- Now the AFRL/VS and CSL have begun a fundamental program to advance mirror fabrication technology.

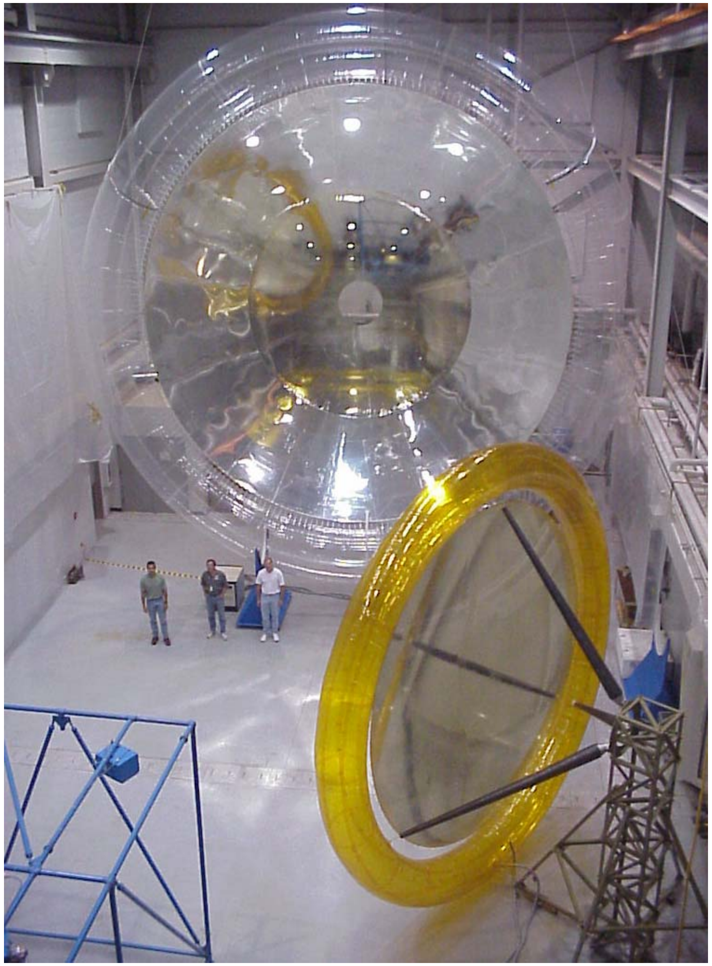
Introduction

- The objective of the new Advanced Mirror Technology Development (AMTD) program is to advance revolutionary concepts for rapid, cost-effective large aperture mirror technology. Two broad classes of technology development are being explored:
  - Precision gossamer apertures
  - Laser-assisted rapid mirror fabrication



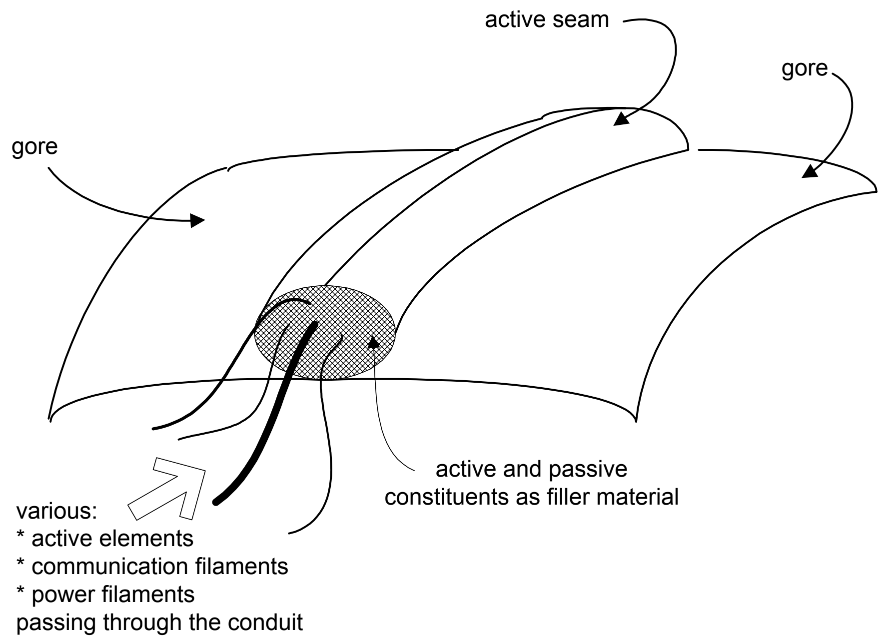
Precision Gossamer Apertures

- Large, ultra-lightweight, deployable space-based reflectors are of current interest to DOD, NASA, and others.
- The most promising candidates are membrane or *gossamer* structures
- We are pursuing active deployment and shape control for these generation after next surveillance systems



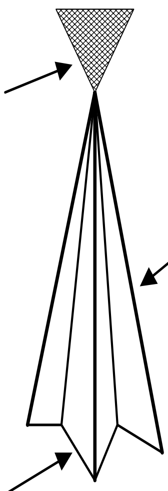
Precision Gossamer Apertures

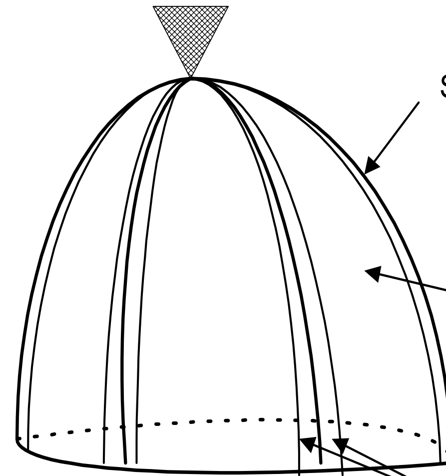
- For deployment and shape control, active elements can be located at the boundaries of the aperture or distributed over its surface.
- We have shown elsewhere that boundary control can be an effective strategy to improve figure accuracy.
- The current research investigates incorporating surface distributed active elements like shape memory alloys and piezoelectric polymers.

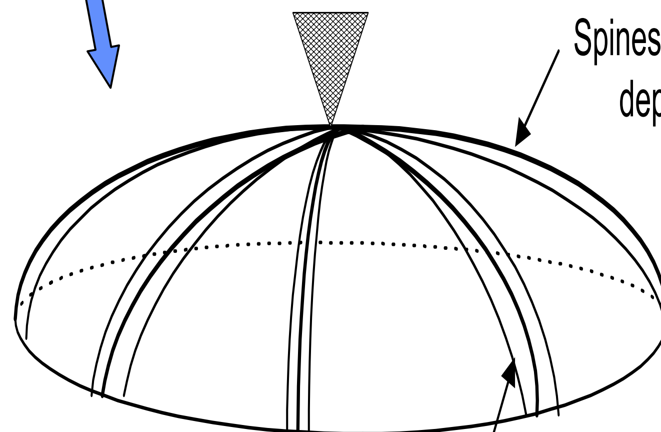


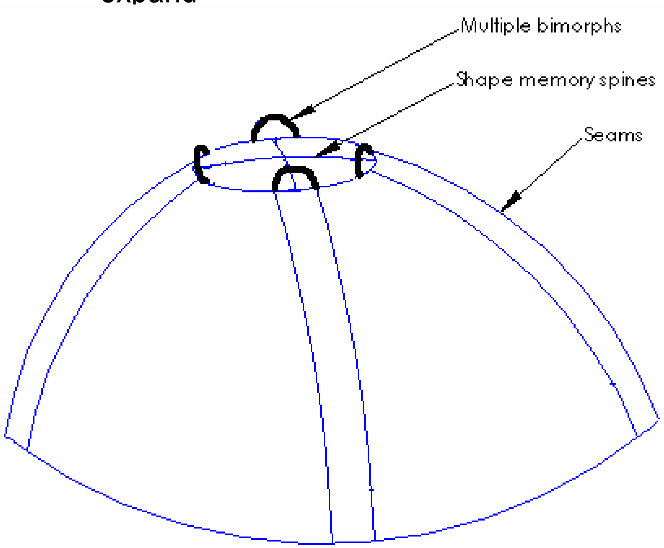
Generic Active Seam
Cross-section of an active seam joining 2 gores

A Notional Concept



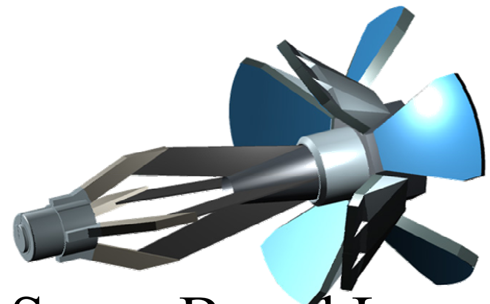




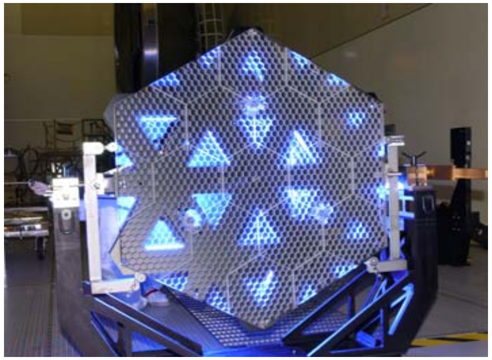


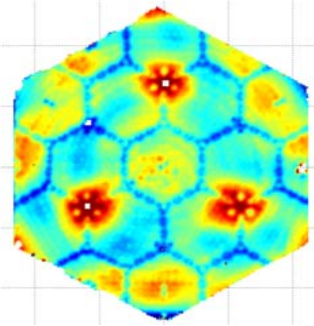
Laser-Assisted Rapid Mirror Fabrication

- It is estimated that the Space-Based Laser program alone will require over 200 m^2 per year of mirrors.
- Current world mirror fabrication capacity is about <u>50 m^2 per year</u>!
- We are pursuing use of our Intelligent Laser Processing to make significant contributions to mirror fabrication needs.



Space Based Laser

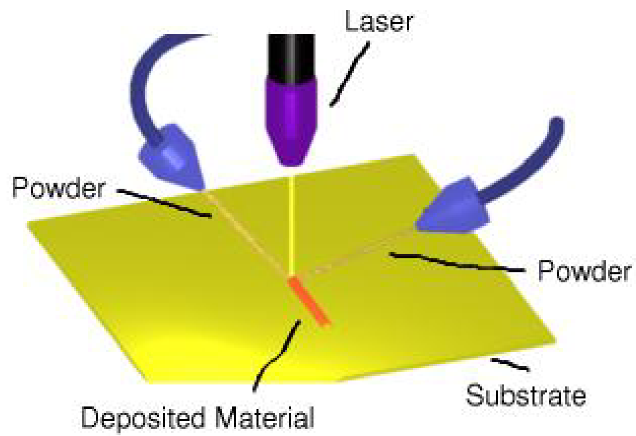


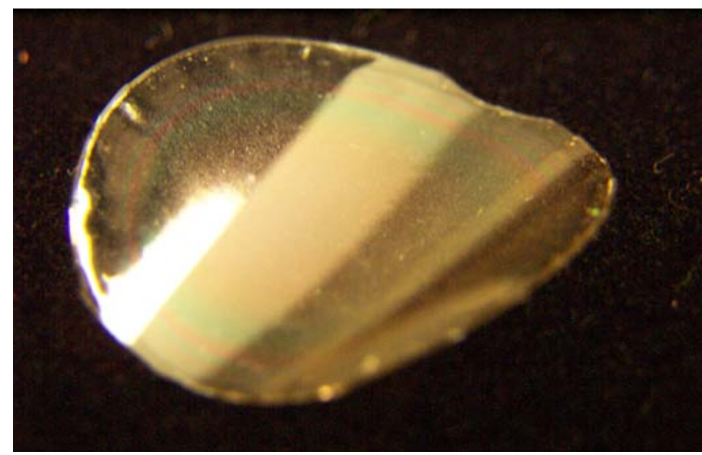


Kodak 1.4m AMSD Mirror, 57nm RMS Figure

Laser-Assisted Rapid Mirror Fabrication

- Two approaches are under investigation:
  - One is the Laser Powder Deposition (LPD) of light, stiff, backing structures onto thin optical facesheets, such as nanolaminates.
  - The other is the LPD of glass directly onto lightweight, stiff backing structures.

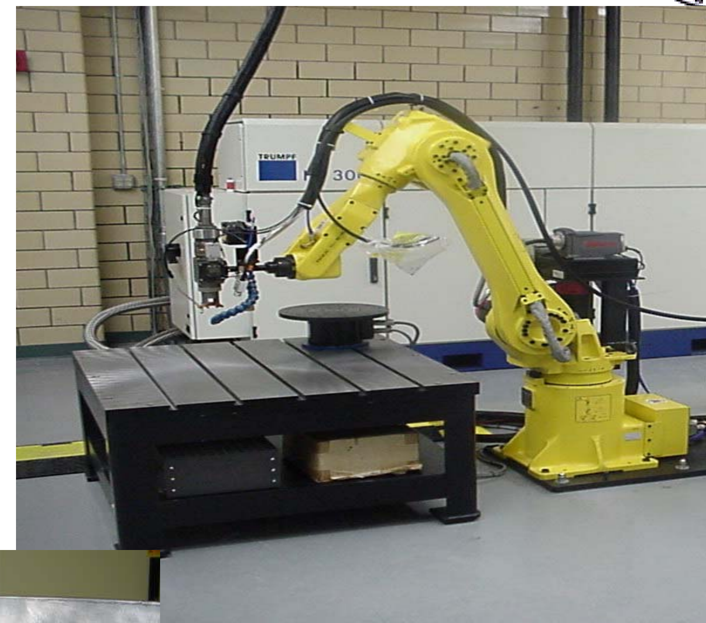


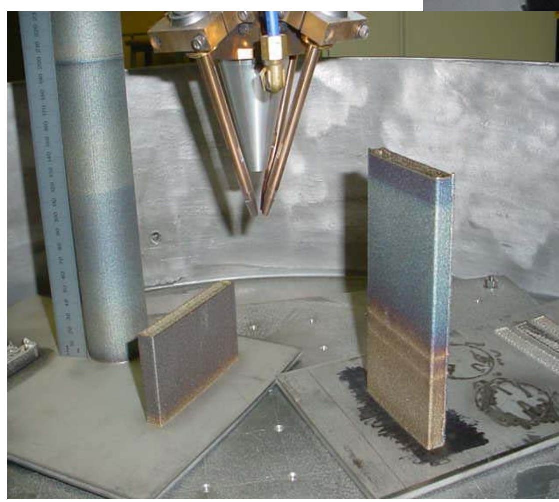


Laser-Assisted Rapid Mirror Fabrication

Two LPD technologies are under assessment.

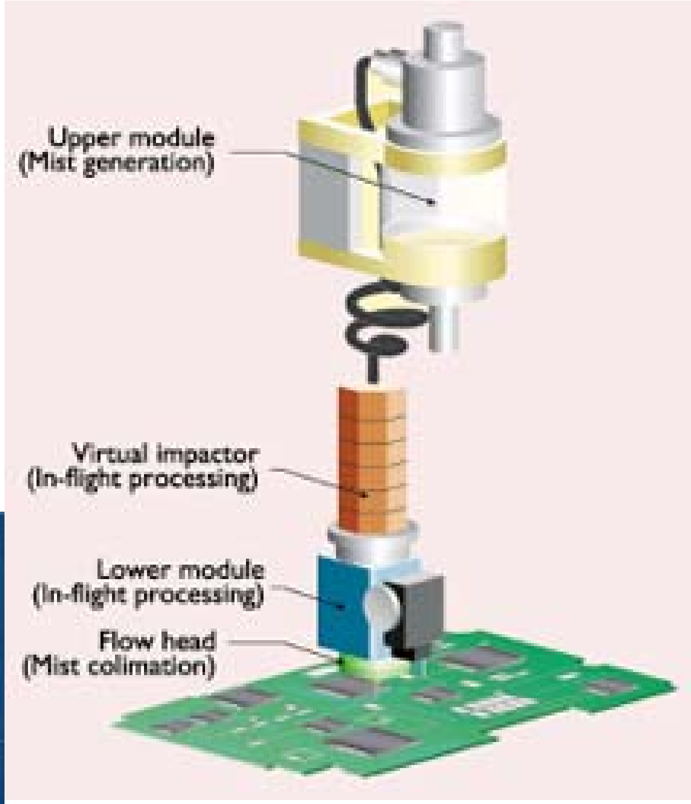
- One uses our 3kW Nd:YAG laser mounted on a 6-axis Fanuc robot. Twin powder feeders supply deposition materials to the laser head via flow nozzles.

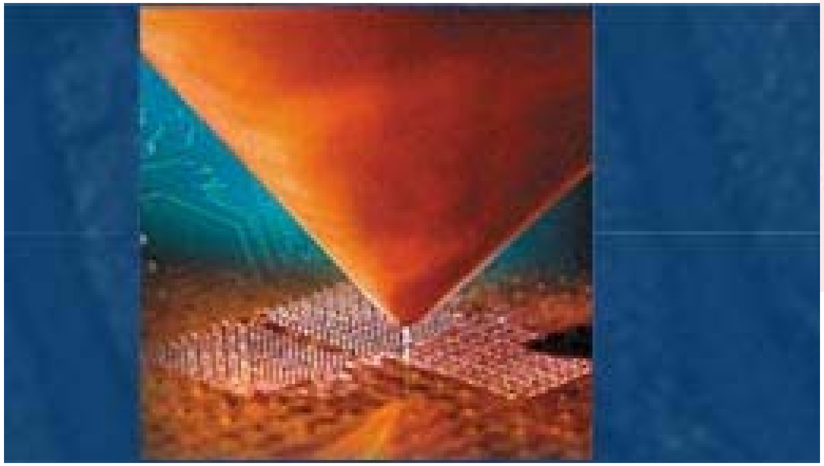




Laser-Assisted Rapid Mirror Fabrication

- The other is Maskless Mesoscale Materials Deposition (M^3D) technology (Optomec, Inc.), which uses an ink-jet process to deposit chemical precursor solutions and colloidal suspensions that are then laser fused.





Acknowledgment

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